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Seasonal Habitat Use and Movements Of Woodland Caribou in the Graham River Drainage, 1988-1994

R. J. Backmeyer
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This report has been approved by the Peace/Williston Fish and Wildlife Compensation Program Fish Technical Committee.

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EXECUTIVE SUMMARY

The Graham River Caribou Study was initiated in 1988 by B.C. Environment, Fort St. John, in response to forest harvesting and silvicultural proposals in the Engelmann Spruce-Subalpine Fir (ESSF) forests. Eleven woodland caribou were fitted with radio-collars between 1988 and 1989. Lack of funding necessitated the suspension of monitoring of collared caribou in July 1990. The Peace/Williston Fish and Wildlife Compensation Program (PWFWCP) resumed monitoring in September 1991 and continued through May 1994. At the commencement of PWFWCP involvement only 5 caribou were still active within the boundary of the study area; 3 animals were confirmed dead and 3 could not be located.

Despite the lack of continuity in monitoring and the loss of the majority of radio-collared animals from the project, the Graham River Caribou Study clearly identified the importance of ESSF and Boreal White and Black Spruce (BWBS) forests. Further research is required to identify migration corridors, critical winter range and calving grounds. This information is necessary to understand the implications of forest extraction, silviculture activities and access development on the Graham River caribou population.

This report was originally submitted in July 1994. A revised version was completed in May 2000, incorporating comments from a review panel of B.C. Environment, B.C. Hydro, and PWFWCP wildlife biologists. At the time of the 1994 writing, the three woodland caribou ecotypes had not yet been described. The March 2000 version has not attempted to introduce new information, but merely to address edits suggested by the review panel.

ACKNOWLEDGEMENTS

Rob Woods, B.C. Environment Wildlife Branch, Fort St. John, supplied net-gunning expertise. Local guide-outfitter, Darwin Watson, volunteered his time to monitor radio-collared caribou during the first six months of the project. Rob Woods assumed monitoring duties from August 1988 until June 1990, when the project was cancelled due to lack of funding. Rod Backmeyer completed the second phase of monitoring, from September 1991 to May 1994.

The report was reviewed by Doug Heard and Lisa Wilkinson of B.C. Environment, Alan Chan-McLeod and Ed Hill of B.C. Hydro, and Mari Wood of PWFWCP.

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1.0 INTRODUCTION

In recent years woodland caribou *(Rangifer tarandus caribou)* habitat in southern British Columbia and Alberta has been adversely affected by timber harvesting, fires and access development for resource extraction and recreation (Edmonds and Bloomfield 1984). As the level of timber harvesting, and oil and natural gas exploration increases in northeastern B.C., the potential for serious impacts on caribou increases as well. Caribou populations once considered remote are now within areas proposed for resource development. Roads built for oil and gas exploration afford access to forests that were previously uneconomical to harvest due to high development costs. The cumulative effect of the two industries threatens the viability of caribou herds in some areas.

The Graham River Caribou Study was initiated in 1988 in response to harvesting and silviculture proposals in the Engelmann Spruce Subalpine Fir (ESSF) forests, which were assumed to provide important seasonal habitat for caribou (Churchill 1988). The objectives of the study were to:

- Identify seasonal ranges of caribou in and adjacent to the ESSF forests of the Rocky Mountain Foothills between Williston Reservoir and Cypress Creek,

- Monitor seasonal movement patterns, with special emphasis on identifying use of forested habitats with potential for forest development.

The study was initiated in February 1988 with funding from the Forest Resource Development Agreement (FRDA). FRDA funding was discontinued for March 1990 and further monitoring was cancelled (Backmeyer 1989). Results from the 1988-1990 monitoring are presented in Murray (1990). The Peace/Williston Fish and Wildlife Compensation Program (PWFWCP) resumed monitoring of the Graham River caribou in September 1991 and continued until May 1994.

This report summarizes the results of the study from its inception in February 1988 to May 1994.

2.0 STUDY AREA

The study area lies approximately 100 km northwest of Fort St. John, and encompasses 7,450 km^2 (Hiebert 1989). It extends from the Ospika River east to the Halfway River, and from Cypress Creek south to the Peace Arm of Williston Reservoir (Fig.1). The area lies mainly in the Peace Foothills ecosection and includes a fringe of the Misinchinka Range ecosection on the west and a portion of the Halfway Plateau ecosection on the east (Demarchi 1988). The majority of the area falls within the Engelmann Spruce-Subalpine Fir (ESSF) biogeoclimatic zone (B.C. Min. of For. 1992), with strips of Boreal White and Black Spruce (BWBS) at low elevations (below 1075 m) in the major valleys and on the Halfway Plateau. Alpine tundra (AT) and associated parkland forests are found on peaks and ridges above 1400 m.

The topography is dominated by major north/south-running ridges dissected by numerous creeks. The study area is drained by four major rivers, which originate in the Rocky Mountains to the west. The Ospika River, which drains the western

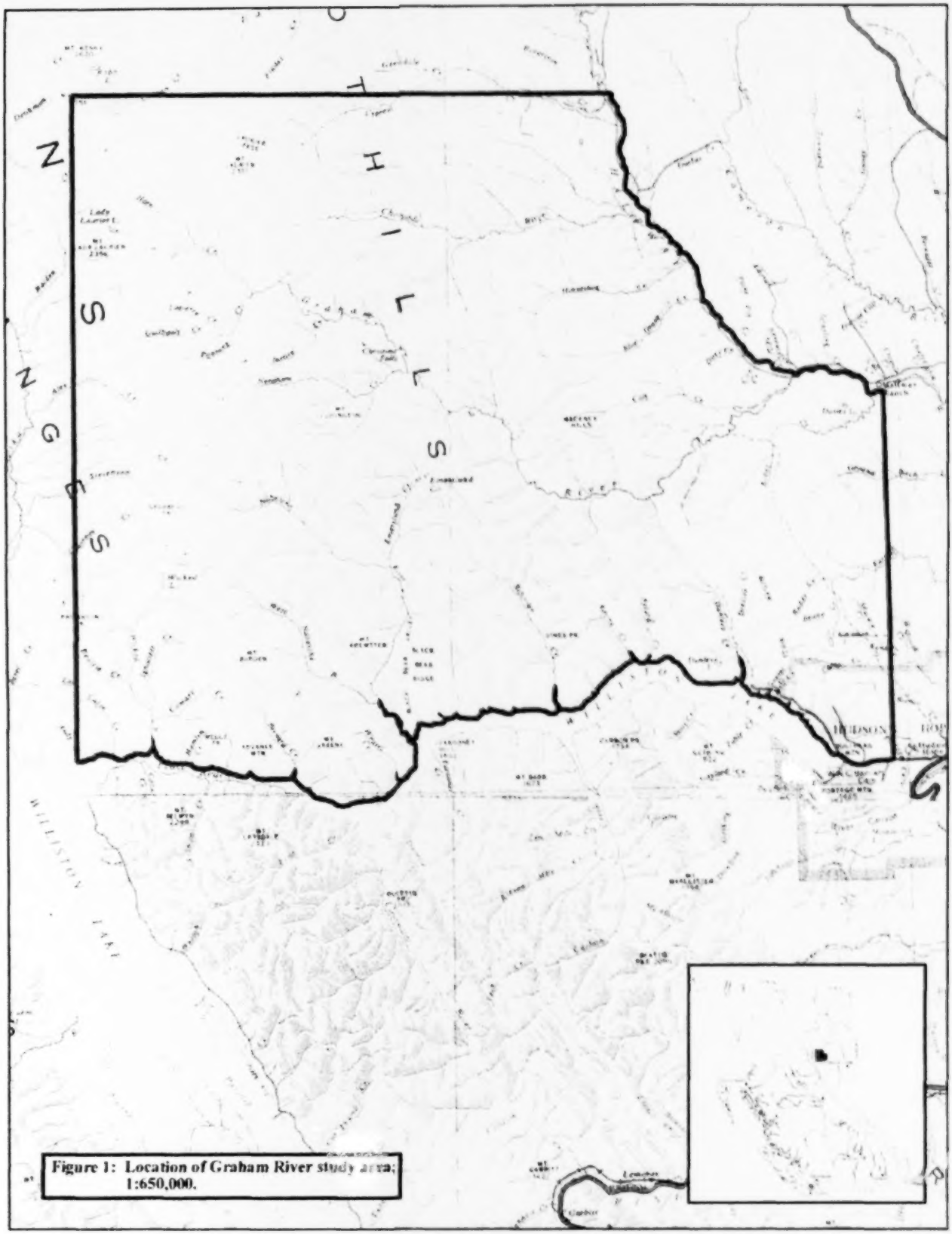

Figure 1: Location of Graham River study area; 1:650,000.

edge of the study area, flows south into the Finlay Arm of Williston Reservoir. The smaller Nabesche River drainage parallels the Ospika, and empties south into the Peace Arm of Williston Reservoir. The Graham River drains the majority of the study area southeast into the Halfway River, which flows southeast into the Peace River.

The climate of the area is sub-arctic, characterized by short cool summers and long cold winters. Precipitation within the study area is variable, with the western portion receiving considerably more rainfall and greater snow accumulations due to the higher mountain elevations (Harper 1984). The eastern portions are drier due to the rain shadow effect as the distance from the mountains increases. Chinook events (warm coastal air flowing through the mountain passes into the valleys east of the Rocky Mountains) are common in the area, resulting in windswept conditions on the eastern-most alpine ridges and reduced snow accumulations on the Halfway Plateau.

3.0 METHODS

3.1 Capture, Collaring, and Radio-telemetry

All caribou were captured using a net-gun fired from a Bell 206B helicopter. Once netted, the caribou were restrained, hobbled and blindfolded. To avoid prolonged stress, and allow immediate release after collaring, immobilizing drugs were not used. Each animal was measured, ear-tagged and fitted with a LMRT-4 radio-collar with mortality option (Lotek Engineering Ltd., Newmarket, ON).

Collared caribou were monitored from either a Piper Supercub or Cesssna 172 fixed-wing aircraft, from February 1988-July 1990 and from September 1991-May 1994. During monitoring flights, all locations were plotted on 1:250,000 NTS maps. Information recorded for each location included: time, weather conditions, habitat type, and number and classification of all caribou observed. Locations were manually transferred to 1:50,000 NTS maps in the office, and UTM co-ordinates, elevation, percent slope and aspect were determined. Locations were also transferred onto forest cover maps to determine forest types. As these maps list most high-elevation forests as "alpine forest", in-flight visual assessments were used to determine the dominant tree-species composition.

3.2 Seasonal Habitat Use

Only 7 locations were obtained from the radio-collared bull; these data were excluded from the analysis. Seasonal habitat use data from collared female caribou were reviewed and found to be similar, therefore all seasonal locations were combined. Five periods of similar habitat use were determined: spring (April/May), summer (June-August), fall (Sept/Oct), early winter (Nov-Jan), and late winter (Feb/March). Seasonal habitat use data were reviewed in two manners:

- Habitat use by biogeoclimatic (BEC) zone was compared. As the level of BEC mapping available for the study area was not adequate to accurately describe habitats at the 1:50,000 scale, three zones were delineated by elevation: BWBS forests (forests under 1075 m), ESSF forests (forests between 1075 m and 1375 m) and alpine/subalpine (habitats above 1375 m). In northeastern B.C. the alpine tundra biogeoclimatic (AT) zone typically occurs above 1400 m (Meidinger and Pojar 1991). For the purpose of this

study, the elevation range was modified to capture variations related to aspect and to include subalpine habitats.

- A second comparison was made of habitat use by dominant forest cover type within the BEC zones. In-flight visual observations of forest coyer were used to define broad forest cover classifications. The three elevation zones, with their corresponding broad habitat categories are shown in Table 1. As Engelmann *(Picea engelmannii)* and white spruce *(Picea glauca)* commonly hybridize (Meidinger and Pojar 1991), the species were classified as generic spruce, as per standard B.C. forest coyer mapping protocol. Current forest cover mapping also fails to distinguish between balsam fir *(Abies balsamea)* and subalpine fir *(Abies lasiocarpa),* grouping both under true fir (forest cover code "B").

Table 1: Elevation (BEC) zones and broad forest cover classes used to determine seasonal habitat use.

BEC Zone	Broad Forest Cover Class	Code
BWBS Forests (forests under 1075 m)	BWBS spruce	BWBS- S
	BWBS lodgepole pine	BWBS - Pl
	BWBS lodgepole pine/ spruce	BWBS - Pl/S
	BWBS black spruce	BWBS- Sb
ESSF forests (1075 to 1375 m)	ESSF spruce/subalpine fir**	ESSF - S/B
	ESSF lodgepole pine	ESSF- Pl
	ESSF black spruce	ESSF -Sb
Alpine/subalpine (above 1375 m)	Alpine/subalpine	AT/Subalpine

* Standard forest cover mapping codes:
S - white spruce (Picea glauca), hybrid Spruce (Picea glauca *K* engelmannii), or Engelmann spruce (Picea engelmannii)
Sb - black spruce (Picea mariana)
Pl - lodgepole pine (Pinus contorta)
**B - true fir (subalpine fir - Abies lasiocarpa)
AT- alpine tundra

3.3 Seasonal Movements

Location data from the only collared bull was excluded from the analysis of seasonal movements. Two aspects of seasonal movements of collared female caribou were considered:

- A comparison of summer versus winter distribution was completed by plotting all late spring and summer locations (May-Oct) and all winter and early spring locations (Nov-April) on 1:250,000 NTS maps. In contrast to the seasonal habitat use periods defined in Section 3.2, summer and winter periods were divided between April and May to account for differences in forage availability associated with snow melt and green-up. Summer and winter ranges were plotted for individual caribou.

- Timing and distance of spring and fall migration were evaluated for caribou that displayed distinct migratory tendencies, with movements of greater than 15 km. Migration timing was determined from consecutive locations that showed major movement in less than 40 days. Migration distances were calculated by straight-line measurements from the centre of the summer range to the centre of the late winter range. The 40-day period was arbitrarily selected as the minimum period when it might be assumed that relocation flights would have occurred, given the inconsistent nature of the monitoring program.

3.4 Home Ranges

Multi-annual home ranges were determined for each individual collared caribou by plotting locations onto 1:250,000 NTS maps. Minimum convex polygons (Mohr 1947) were determined by using straight lines to connect peripheral location points. Home range sizes were calculated by digital planimeter. Although a home range polygon was plotted for the collared male, data from this animal were excluded from the analysis of mean home range size. Female 149.405 was relocated only during winter flights, therefore it was also excluded from the analysis on annual home range size.

4.0 RESULTS

4.1 Capture, Collaring, and Radio-telemetry

A total of 11 caribou were radio-collared during the course of the study: 9 females in February 1988, and 1 female and 1 male in February 1989. One of the original 9 animals collared died in the fall of 1988; the collar was retrieved and fitted on the female captured in February 1989. All caribou were captured in alpine habitat along the eastern-most ridges of the Peace Foothills ecosection. There was no attempt to locate or capture caribou in low elevation forested habitat. Capture and collaring results are summarized in Appendix I. All captured caribou appeared to be in good health and showed no signs of injury or excessive stress at the time of release.

Location flights were originally proposed on a bi-weekly basis for May, June, October and February, and monthly throughout the rest of the year. From February 1988 to July 1988, relocations were conducted on a somewhat erratic basis. B.C. Environment staff assumed monitoring duties in August 1988. Monitoring was sporadic between August 1988 and June 1990 due to lack of staff time and minimal budgets. Only 11 radio-telemetry flights were completed in this 23-month period. The Graham River Caribou Study was subsequently cancelled in July 1990, and monitoring of the animals ceased for a 14-month period. The project was resumed by the PWFWCP in September 1991; 4 collared caribou were alive at this point. Three collars were transmitting mortality signals (these caribou were subsequently found to be dead), and 3 caribou could not be located. Between September 1991 and May 1994, monitoring was completed on a monthly basis in conjunction with other radio-telemetry studies in the Peace Arm area. Thirty radio-location flights were conducted during this 33-month period; some flights were missed due to adverse weather conditions. In summary, 88 radio-location flights were conducted for collared caribou in the Graham River area over a 76-month period, resulting in 270 caribou locations (Appendix II).

4.2 Seasonal Habitat Use

Radio-collared female caribou used a variety of habitats throughout the study. Alpine/subalpine habitats and ESSF forests were used during all seasons, with the highest use of alpine/subalpine occurring in summer (65%) and late winter (68%) (Fig. 2). Use of ESSF forests was highest in fall (56%) and lowest in late winter (18%). BWBS forests were used in all seasons except summer, with the peak use in spring (35%).

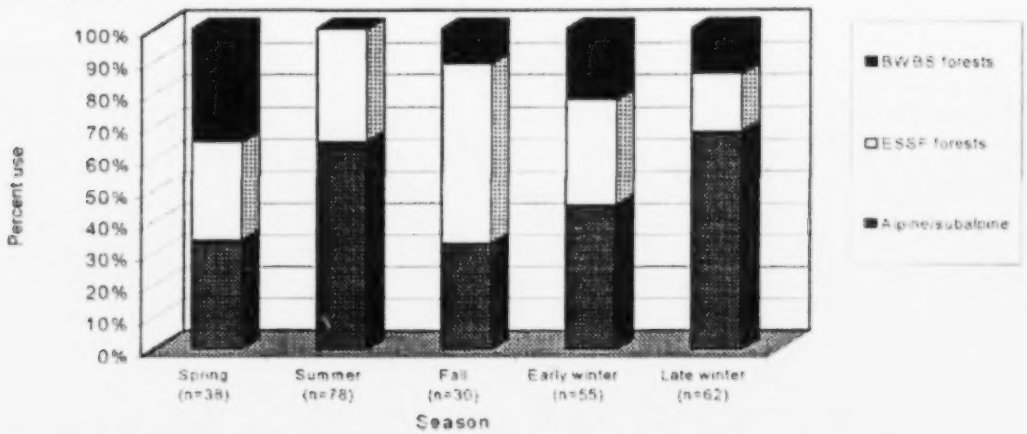

Figure 2: Seasonal use of BEC zones by radio-collared female caribou in the Graham River study area, 1988-1994.

Within the ESSF zone there was comparable use of both spruce/fir forests and lodgepole pine forests throughout the year, and some use of black spruce forests in spring and fall (Fig. 3). In the BWBS zone, caribou use of black spruce forests increased, while the use of pine and spruce forests was reduced.

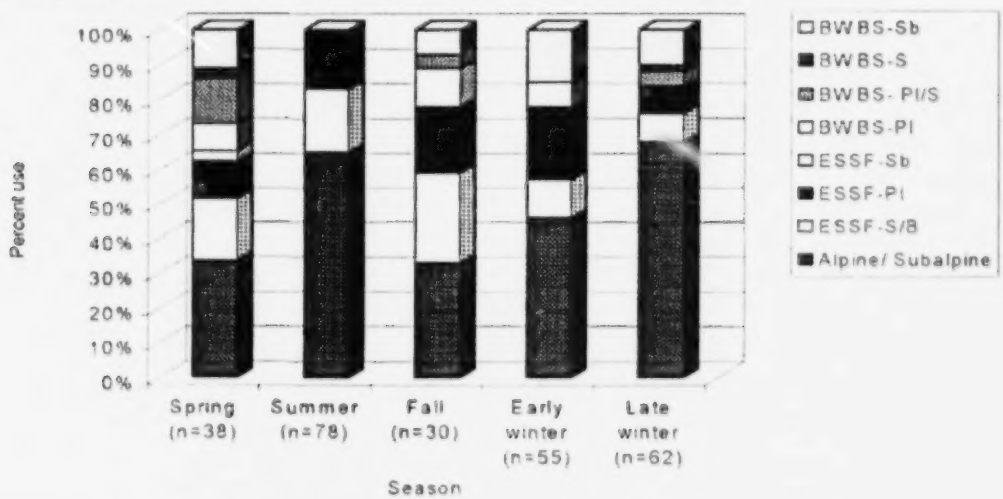

Figure 3: Seasonal use of forest cover types by radio-collared female caribou in the Graham River study area, 1988-1994.

4.3 Seasonal Movements

Seasonal movements varied considerably among the 10 radio-collared female caribou. With the exception of caribou 149.465, all radio-collared females appeared to be migratory, with movements greater than 15 km between summer and winter ranges. Caribou 149.465 used overlapping areas for summer and winter. Although it did use distinct seasonal areas during different years of the study, there was no discernable fidelity to any seasonal range. Caribou 149.410 and 149.445 were migratory in some years but remained on their summer ranges through at least one winter. Caribou 149.405 was considered to be migratory as it was not located in summer but returned to the capture area during winter. Figure 4 shows summer and winter location points for all radio-collared caribou in the Graham River Caribou Study.

Spring and fall migrations are not well defined due to the time lapse between subsequent location flights, and the inconsistent timing of flights (Fig. 5). Spring and fall movements of more than 15 km in 40 days or less are summarized in Table 2.

Table 2: Documented spring and fall movements of radio-collared female caribou.

Caribou (Frequency)	Year	Location Dates	Number of Days	Distance Moved (km)	Movement Number*
149.395	1988	May 28-June 1	5	17	1
	1990	May 23-June5	14	18	2
	1991	Oct. 29-Nov. 26	29	33	3
	1992	April 15-May 15	30	24	4
	1992	Oct. 28-Nov. 24	28	28	5
149.425	1988	May 4-June 10	38	74	6
	1991	Sept26-Oct 17	22	61	7
149.435a	1988	April 28 -May 31	34	20	8
149.445	1988	May 3-June 12	38	38	9
149.455	1988	May 4-June 10	39	57	10
	1992	April 15-May 15	30	56	11
	1993	April 29-June 6	39	31	12
149.405	1990	May 23-June 5	14	15	13
149.410	1991	Dec. 13-Dec. 28	15	15	14
	1992	April 15-May 15	30	30	15
	1992	Oct. 28-Nov. 24	28	22	16

* Number of movement corresponds to migration lines on Figure 5.

Figure 4: Summer and winter locations of radio-collared caribou in the Graham River area, 1985-1994; 1:250,000 NTS.

- winter
- summer

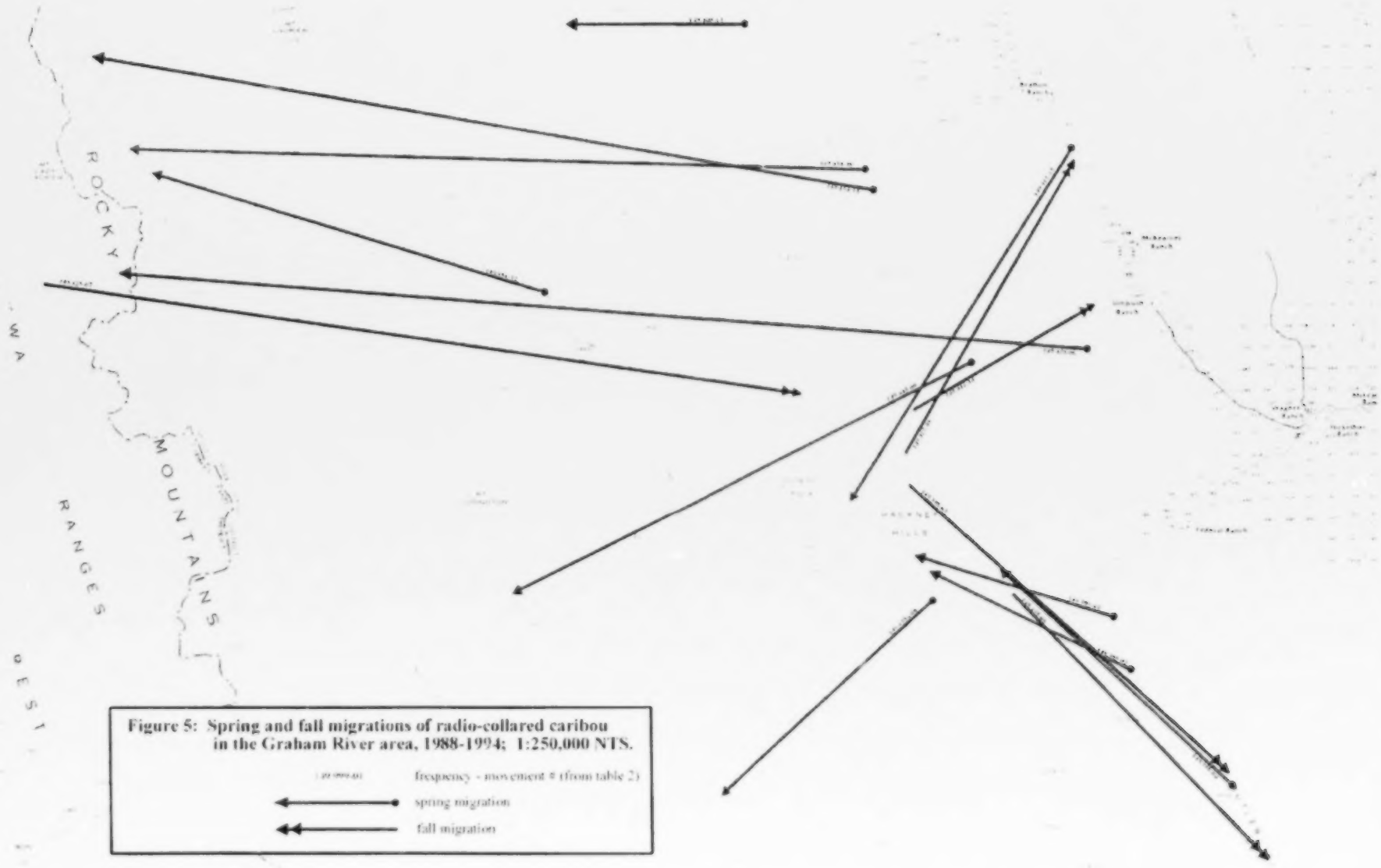

Figure 5: Spring and fall migrations of radio-collared caribou in the Graham River area, 1988-1994; 1:250,000 NTS.

frequency - movement # (from table 2)

spring migration

fall migration

Seasonal elevational movements of radio-collared female caribou were closely related to habitat use. Distinct elevational movements were evident among the population as a whole. There was a general move towards lower elevation forests in spring, then towards high elevation alpine and subalpine forests in the summer. Fall and early winter use showed little sign of elevational preference; as winter progressed there was a split in elevational use with some individuals moving to higher elevations while others moved to low elevation forests.

4.4 Home Ranges

Figure 6 shows home range polygons for radio-collared caribou monitored during the study. Female 149.405 was never located during summer months, therefore no home range polygon was plotted. Data on this animal and the bull were excluded from the calculation of mean home range size (Table 3). Multi-annual home ranges of individual radio-collared female caribou were highly variable, ranging from 350 km^2 to 963 km^2 (mean of 595.33 km^2) .

Table 3: Home range sizes and distance travelled between seasonal ranges of 9 female radio-collared caribou from the Graham River study area.

Caribou*	No. of locations	Home range size (km^2)	Distance measured between summer and winter ranges (km.)
149.395	47	371	33
149.410	45	350	**28**
149.425	34	963	70
149.435a	12	350	30
149.435b	6	563	62
149.445	**18**	**780**	32
149.455	37	**843**	40
149.465	49	534	Resident
149.475	9	604	60
Mean	**28.5**	595.33	**44.38**

* Radio-collar frequencies may appear ± .003 on some data sheets due to frequency drift associated with temperature change.

** 149.405 was relocated only during winter flights, therefore it was excluded from home range sample.

5.0 DISCUSSION

Caribou studies in similar habitats in northern B.C. (Sopuck 1985) and west central Alberta (Edmonds and Bloomfield 1984) have shown significant differences in home range sizes, migration distances and migration timing between male and female caribou. Therefore, the results of this study may not be indicative of habitat use, seasonal movements, and home ranges for bulls or disbursing juveniles.

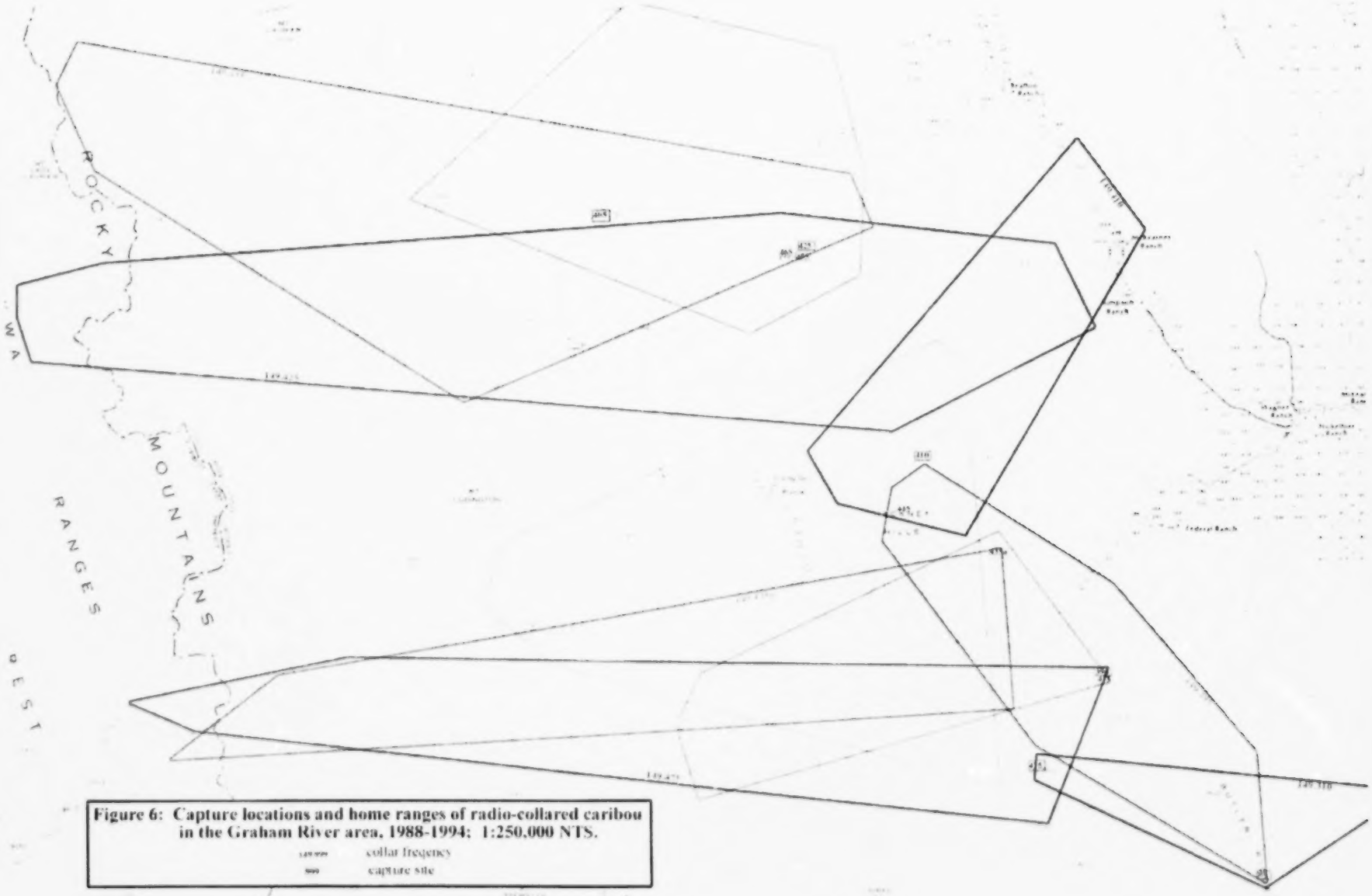

Figure 6: Capture locations and home ranges of radio-collared caribou in the Graham River area, 1988-1994; 1:250,000 NTS.

collar frequency

capture site

5.1 Capture, Collaring, and Radio-telemetry

As all caribou in the study were collared in alpine habitat, a bias toward use of high elevation habitats in subsequent winters may exist. This study also documents low elevation wintering activities; any further studies should incorporate low elevation captures. Caribou studies south of Dawson Creek (Sopuck 1985) and in west central Alberta have documented populations that are permanent residents of low elevation boreal forests (Edmonds and Bloomfield 1984). Caribou using these BWBS forests for significant periods of time or as critical seasonal habitat could be seriously affected by resource development and timber extraction. The results of this study do not adequately identify potential conflict areas nor do they provide enough information to develop integrated management guidelines.

The inconclusive data from this study are partly a result of inconsistent monitoring. A long-term financial and staffing commitment would have contributed to better results. Considering the financial constraints of many projects, cost-cutting efforts such as the use of volunteers would seem to be an asset, however the integrity of the data should not be dependent on such measures.

5.2 Seasonal Habitat Use

The Graham River Caribou Study clearly identifies the use of both ESSF and BWBS forests, although the specific use of forest cover types is not clear. Implications of forest extraction, silvicultural activities, and access development on the caribou population within the study area are still largely unknown. Edmonds and Bloomfield (1984) and Simpson (1994) cite loss of habitat, habitat fragmentation, and human disturbance as factors contributing to declines in caribou populations. While there are many similarities between this study and the west central Alberta caribou study, there are also significant differences. Edmonds and Bloomfield reported only a small proportion of the west central Alberta population using alpine habitat in winter, whereas all collared caribou in the Graham River study spent some time in alpine habitat. As wintering strategies vary significantly between the two populations, forestry guidelines developed for west central Alberta may not be transferable to the Graham River area. Recently developed caribou/ forestry guidelines for southern B.C. (Simpson 1994) are based on caribou that winter in forests with heavy snow accumulations and high production of arboreal lichens, which is dissimilar to the situation in the Graham River area. If caribou habitat in northeastern B.C. is to be adequately protected, integrated caribou/forestry guidelines must be developed specific to northeastern caribou populations and northeastern forests. Further information is required to develop adequate guidelines.

Seasonal habitat use of the Graham River caribou population is consistent with use documented in the Wolverine and Chase herds, west of Williston Reservoir (Wood 1996), in west central Alberta (Edmonds and Bloomfield 1984), and the Quintette area near Tumbler Ridge (Sopuck 1985). Caribou populations in these areas use two distinct winter habitats: wind-swept alpine, and flat to gently sloping low-elevation boreal forests. The percentage of the population using each habitat is variable and may be related to snow depth. Sopuck (1985) estimated that 41 to 55% of the caribou population in the Quintette area remained in alpine habitat during winter. Wood (1996) found the use of high and low elevation winter ranges appeared to be correlated to snow depths. Deep snow conditions appeared to force caribou to winter in the alpine, while lesser snow accumulations allowed them to remain in low elevation timber. Data from the Graham River Caribou Study is

insufficient to determine the extent of caribou use of alpine and low elevation forests. The Graham caribou appeared to make use of both alpine/subalpine and low elevation habitats during winter; all radio-collared caribou wintered in alpine/subalpine habitat at some point during the study, while approximately 50 % of collared animals were also located in BWBS forests at some point.

All radio-collared caribou wintering in low to mid-elevation forests returned to alpine/subalpine and ESSF habitats by early June. No animals were located in BWBS forests during summer months (June-Aug) This pattern is consistent with findings from the Wolverine-Chase herds (Wood 1996), west central Alberta, (Edmonds and Bloomfield 1984) and Quintette (Sopuck 1985). Specific rutting areas could not be defined in the Graham River study due to limited locations.

The use of various forest types within biogeoclimatic zones was difficult to determine. The Graham River data indicates a relatively high use of black spruce muskeg while wintering in the BWBS zone. Edmonds and Bloomfield (1984) found that pine and pine/spruce forests were used most often, but open meadow habitats were selected for bedding, possibly for easier detection of predators. Faecal analysis of the west central Alberta population (Edmonds and Bloomfield 1984) showed a preference for terrestrial lichens (66%) over arboreal lichens (2%). The Graham River caribou herd's high use of black spruce muskeg, the most open forest type in the BWBS, may be the result of mid-day monitoring flights locating caribou in their bedding areas rather than their feeding sites. Alternately, the high incidence of muskeg locations may indicate forage selection. Caribou use of muskeg habitats needs to be clarified as the implications for integrated forest management are significant.

The lack of locations in deciduous or mixed wood forests is notable. Only one of 270 locations in the Graham River study was in a deciduous forest. Edmonds and Bloomfield (1984) also report an avoidance of aspen and mixed aspen/coniferous forests. However, Wood (1996) found caribou use mixed aspen/conifer and pure aspen stands during spring (April/May).

5.3 Seasonal Movements

Data from the Graham River Caribou Study is not detailed enough to establish firm migration dates. Spring migrations may start as early as mid-April, with all caribou on the summer ranges by the first week of June. Edmonds and Bloomfield (1984) suggest spring migrations are largely dependant on snow cover, with migration beginning in early April in low-snow years or as late as mid-May if heavy snow accumulations persist. Sopuck (1985) identified the Quintette caribou spring migration period as April 1 to May 19. Graham River caribou appear to calve on or near their summer ranges, but there is insufficient data to be conclusive.

Fall migrations are, again, not well defined. Movement generally began after the rut, in late October and November. Some individual caribou remained on summer ranges during certain winters. Some made quick migrations to the winter range while others did not arrive on the winter range until January. Fall migration may be dependant on snow conditions and accumulations. Wood (1996), Edmonds and Bloomfield (1984), and Sopuck (1985) found fall migrations to be highly variable.

The Graham River caribou showed a wide range of seasonal movements. Seasonal movements ranged from 1 resident individual with no discernable migrations to several animals with movements of up to 70 km. The mean migration

distance for migratory caribou in the Graham River study is 41.4 km. The Quintette study reports a mean migration distance of 36.2 km (Sopuck 1985).

Edmonds and Bloomfield (1984) suggest caribou seasonal movements may be dependent on snow accumulations, snow conditions or industrial disturbance. Two of the Graham River radio-collared caribou did not migrate to their usual winter range in at least one year, possibly the result of low snow accumulations. Throughout the study, Caribou 149.455 made a gradual winter migration from the headwaters of Horn Creek, toward Christina Falls on the Graham River. The extent of travel varied anually, and may have been determined by snow accumulations, but no snow depth data is available for this specific area. Caribou 149.410 was a resident in the Bluegrave Pass area from February 1988 to December 1991 when she made a sudden movement of 28 km, east, to the Halfway River. This winter migration pattern continued for the remainder of the study. Forest harvesting was planned for a major portion of this animal's original home range. Clear-cutting began in 1991 and continued in various cut blocks through 1993. The shift in home range and migrational movements may be directly related to the forest harvesting, however no definitive conclusions can be made based on the activities of 1 caribou.

5.4 Home Ranges

Home range sizes of the Graham River caribou varied from 350 - 963 km^2, with a mean of 595.33 km^2. This corresponds to the Quintette caribou study, which found home ranges of 230 - 667 km^2 with a mean of 491 km^2 (Sopuck 1985). No attempt was made to determine seasonal home ranges of the Graham River caribou due to the low number of locations, although some individuals do appear to have distinct seasonal ranges. Much of the area between these seasonal ranges had no locations and may be best described as travel corridor rather than home range, however the exact travel routes are unknown.

6.0 RECOMMENDATIONS

The following recommendations are designed to provide protection of critical caribou habitat in the absence of more concrete data and to gather information necessary to develop integrated caribou/forestry guidelines for this area of the province.

6.1 Habitat Protection Recommendations

The windswept alpine/subalpine and high elevation ESSF forest habitats in the eastern portion of the Rocky Mountain Foothills are critical high-elevation caribou winter range. Critical habitat includes all of the ridges east of a line that runs from the mouth of Aylard Creek in a north/northwest direction to Crying Girl Prairie and continues up the wide valley north of Crying Girl, crosses the Chowade River and continues to Cypress Creek. This belt of critical caribou habitat probably continues north, but Cypress Creek was the northern boundary of the study area. Although preferences for specific habitat types have not been identified by this study, the following measures are suggested to protect these habitats in the absence of more conclusive data.

- Restrict industrial development above 1375 m, including no forest extraction and no road development.

- Implement a motor vehicle closure on all land above 1375 m.

- Restrict seismic activity to hand-cut heliportable between July 15 and October 15 only.

- Reclaim existing forest roads within the Rocky Mountain Foothills immediately after forest harvesting is complete. This includes specifically, the Kobes Creek road, Windfall Creek road, Summit road (off the Bluegrave Creek road), and the Colt Creek road. Future roads into critical habitat should be planned as temporary access only.

- Explore options to protect habitat in the ESSF and BWBS forests. Further study is required to identify travel corridors and areas of high forage production. Industrial development plans in these areas must include consideration and mitigation of impacts on caribou.

6.2 Future Study Direction

Further study is required to adequately identify caribou use in forested habitat, including: seasonal habitat use, foraging preferences and specific habitat selection such as travel corridors, bedding sites, etc. Additional radio-telemetry research is required to achieve these objectives. The recommended project outline is as follows:

- Radio-collar a minimum of 20 caribou in low-elevation forested and alpine habitats on the eastern-most ridges of the Rocky Mountain Foothills.

- Conduct intensive aerial and ground locations of radio-collared caribou for at least 3 years, to account for inter-annual variation. Emphasis should be placed on identifying migration periods, winter habitat selection, and calving areas.

- Conduct winter helicopter surveys of low-elevation ESSF and BWBS forests between the alpine ridges and the Halfway River, from Cypress Creek to Farrell Creek. The first survey could be done in conjunction with the caribou capture work.

- Conduct winter helicopter surveys of the alpine habitat proposed for protection.

- Conduct ground analysis of winter feeding sites in forested habitats, including faecal pellet collection and analysis, and snow depth surveys. Follow up with summer vegetation analysis of winter feeding sites.

- Carry out winter track counts on major access routes through the study area to determine travel corridors.

The mandate of the PWFWCP is to enhance and protect fish and wildlife resources in the Williston Reservoir watershed. The majority of the critical range and areas of possible caribou/forestry conflict identified in this report lie outside of the Williston Reservoir watershed. Only the Butler Ridge and Aylard Ridge areas are of major concern for caribou values within the watershed boundaries. Future project involvement should be limited to monitoring caribou activities within the

Williston drainage area, including winter aerial surveys of alpine habitats and analysis of winter feeding sites. As well, PWFWCP could co-ordinate planning with forest companies to ensure forest extraction does not adversely affect critical caribou ranges and travel corridors within its mandated area.

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APPENDICES I - V

Appendix I: Graham River Caribou Study capture information.

Collar/Frequency	Capture date	Sex	Age	Ear Tag Colour	Right Ear	Lett Ear	Total Length cm.	Tail Length cm.	Chest Girth cm.	Neck Girth cm.	Hind leg Length cm.
A 149.395	12/2/88	F	adult	orange	337	338	180	15	114	45	-
B 149.405	23/02/88	F	adult	orange	332	331	208	17	126	50	57
C 149.410	12/2/88	F	adult	white	348	347	203	18	-	57	-
D 149.425	12/2/88	F	adult	orange	340	339	193	14	-	52	-
E1 149.435	23/02/88	F	adult	purple	339	340	-	-	-	-	-
F 149.445	23/02/88	F	adult	orange	333	334	213	16	138	50	34
G 149.455	12/2/88	F	yrlg	white	305	306	181	14	-	36	-
H 149.465	5/2/88	F	adult	orange	335	336	198	15	137	58	-
I 149.475	23/02/88	F	adult	white	307	310	241	20	137	64	60
E2 149.435	25/02/89	F	adult	red	56	56	241	-	119	49	58
J 148.310	25/02/89	M	adult	red	55	55	-	-	-	-	-

Appendix II: Monitoring duration and frequency of locations for collared caribou.

Name	Collar Frequency	Capture Date	Last Location:	Total Locations	Status
A	149.395	12/02/88	28/04/94	47	Dead April 1994
B	149.405	23/02/88	05/06/90	11	Unknown
C	149.410	12/02/88	28/04/94	45	Active April 1994
D	149.425	12/02/88	08/02/89	34	Dead Dec. 1989
E[1]	149.435	23/02/88	08/02/89	7	Dead Feb. 1989*
E[2]	149.435a**	25/02/89	26/09/91	6	Dead Sept. 1991♦
F	149.445	23/02/88	26/06/91	18	Dead Sept. 1991♦
G	149.455	12/02/88	28/04/94	37	Active April 1994
H	149.465	05/02/88	26/05/94	49	Active May 1994
I	149.475	23/02/88	04/07/90	9	Unknown
J	148.310★	25/02/89	05/03/90	7	Unknown

* Died in Fall of 1988, collared retrieved Feb 1989.
** Collar retrieved from dead caribou, fitted on second female Feb. 1989.
♦ These caribou had not been located for several months prior to the September 9th flight; death may have occurred at any time during the monitoring gap.
★ Excluded from analysis.

Appendix III: Habitat use of female collared caribou by biogeoclimatic zone and season.

Season	n	Percent Use by Biogeoclimatic Zone		
		Alpine/subalpine	ESSF Forests	BWBS Forests
Spring	38	34	31	35
Summer	78	65	35	0
Fall	30	33	56	11
Early winter	55	45	33	22
Late winter	62	68	18	14

Appendix IV: Caribou habitat use by forest cover and season.

Season	n	Bioqeoclimatic zone						
		Alpine/ subalpine	ESSF			BWBS		
			Sw/B	Pl	Sb	Pl	Pl/Sw	Sw	Sb
Spring	38	34	18	11	3	8	13	3	11
Summer	78	65	18	17	0	0	0	0	0
Fall	30	33	26	19	11	0	4	0	7
Early winter	55	46	11	21	0	7	0	0	15
Late winter	62	68	8	8	0	0	4	2	10

Appendix V: Graham River caribou relocations - February 1998 through May 1994.

GRAHAM RIVER CARIBOU RELOCATIONS - FEBRUARY 1988 THROUGH MAY 1994									
Frequency	Date	Location	Easting	Northing	Elevation	% Slope	Aspect	Forest Cover	Comments
149.395	2/12/88	Graham River	5313	62420	5000	60	270	Alpine	
149.395	3/30/88	Graham River	5326	62437	5000	12	110	Alpine	
149.395	4/28/88	Graham River	5324	62501	3100	40	270	SwPl-530M	
149.395	5/28/88	Graham River	5279	62513	3500	18	360	Sw(Pl)-630M	
149.395	6/1/88	Hackney Hills	5169	62555	5300	12	300	Alpine	
149.395	6/10/88	Hackney Hills	5159	62544	5200	30	250	Subalpine	
149.395	7/9/88	Hackney Hills	5198	62561	4700	6	110	Pl(Sw)-420P	
149.395	11/20/88	Butler Ridge	5446	62260	5500	12	180	Alpine	
149.395	12/14/88	Butler Ridge	5434	62318	5300	6	360	Alpine	
149.395	2/8/89	Butler Ridge	5407	62369	4800	50	20	Subalpine	
149.395	8/12/89	Colt Creek	5222	62545	4150	6	240	NcSw-722P	
149.395	8/27/89	Colt Creek	5234	62567	4250	40	40	Sw(Pl)-520P	
149.395	11/23/89	Colt Creek	5239	62558	4400	30	90	Subalpine	
149.395	2/13/90	Butler Ridge	5438	62296	5300	12	280	Alpine	
149.395	3/5/90	Butler Ridge	5398	62363	4000	50	270	NSR burn	
149.395	5/23/90	Graham River	5326	62446	4500	60	30	Subalpine	
149.395	6/5/90	Hackney Hills	5179	62547	4900	6	100	Subalpine	
149.395	7/4/90	Colt Creek	5252	62543	4100	24	90	Subalpine	
149.395	9/26/91	Colt Creek	5191	62581	3900	12	110	Pl(Sw)-532M	
149.395	10/17/91	Bluegrave Creek	5155	62575	4400	30	340	Sb boa	
149.395	10/29/91	Bluegrave Creek	5168	62590	5300	12	90	Alpine	
149.395	11/14/91	Hackney Hills	-	-	-	-	-	-	
149.395	11/26/91	Butler Ridge	5426	62390	3150	12	40	API-422	
149.395	12/13/91	Butler Ridge	5407	62373	4600	50	100	Alpine	
149.395	12/28/91	Butler Ridge	5395	62388	4800	12	ridge	Alpine	
149.395	2/20/92	Butler Ridge	5392	62390	5200	18	220	Alpine	

149.395	5/15/92	Hackney Hills	5209	62532	4300	12	90	Pine	
149.395	6/7/92	Hackney Hills	5188	62561	5100	6	90	Subalpine	
149.395	8/1/92	Bluegrave Creek	5173	62598	4400	20	360	Mature SwB	
149.395	9/30/92	Graham River	5299	62508	3100	12	60	PISw-631	
149.395	10/28/92	Hackney Hills	5242	62510	4600	10	270	PI-531	
149.395	11/24/92	Butler Ridge	5438	62307	5300	10	ridge	Alpine	
149.395	1/9/93	Butler Ridge	5407	62374	4600	36	90	Alpine	
149.395	1/28/93	Butler Ridge	5412	62367	4200	40	80	Alpine	
149.395	2/24/93	Butler Ridge	5437	62305	5400	10	250	Alpine	
149.395	3/12/93	Butler Ridge	5442	62292	5400	10	270	Alpine	
149.395	4/29/93	Butler Ridge	5429	62333	4400	40	70	Subalpine	
149.395	7/26/93	Aylard Ridge	5269	62393	4600	20	180	Subalpine	
149.395	8/19/93	Aylard Ridge	5264	62392	4900	12	360	Subalpine	
149.395	9/18/93	Aylard Ridge	5247	62409	4300	18	240	Mature SwB	
149.395	11/5/93	Dunlevy Ridge	5336	62391	4950	18	170	Subalpine	
149.395	12/16/93	Graham River	5323	62429	5050	24	110	Subalpine	
149.395	1/30/94	Graham River	5320	62460	4600	12	90	Subalpine	
149.395	3/8/94	Graham River	5331	62439	4800	10	90	Alpine	
149.395	4/28/94	Graham River	5304	62489	2900	20	340	Mature Sw	Mortality signal
149.405	**2/23/88**	**Chowade River**	**4961**	**62789**	**5800**	**6**	**270**	**Alpine**	
149.405	5/4/88	Chowade River	5129	62890	3250	6	320	PISw-822P	
149.405	5/22/88	Cypress Creek	4968	63011	5200	12	300	Subalpine	
149.405	6/3/88	Cypress Creek	5020	63029	4800	30	300	Subalpine	
149.405	6/10/88	Cypress Creek	4977	62963	5250	24	260	Subalpine	
149.405	6/22/88	Cypress Creek	4900	62955	6100	6	30	Alpine	
149.405	7/7/88	Cypress Creek	4835	62922	6100	6	240	Alpine	
149.405	7/31/88	Cypress Creek	4976	62981	5150	18	220	Subalpine	
149.405	2/9/89	Chowade River	5085	62788	5350	12	360	Alpine	
149.405	5/23/90	Chowade River	5048	62930	4900	40	90	Subalpine	
149.405	6/5/90	Cypress Creek	4914	62935	5500	18	80	Subalpine	
149.410	**2/12/88**	**Bluegrave Creek**	**5184**	**62608**	**4900**	**flat**	**nil**	**Alpine**	

149.405	5/23/90	Chowade River	5048	62930	4900	40	90	Subalpine	
149.405	6/5/90	Cypress Creek	4914	62935	5500	18	80	Subalpine	
149.410	**2/12/88**	**Bluegrave Creek**	**5184**	**62608**	**4900**	**flat**	**nil**	**Alpine**	
149.410	3/30/88	Blueqrave Creek	5222	62575	4700	12	270	PI-522P	
149.410	4/28/88	Bluegrave Creek	5206	62698	3500	12	30	PI-522P	
149.410	5/3/88	Bluegrave Creek	5112	62625	4150	18	10	Sw(B)-821P	
149.410	5/30/88	Bluegrave Creek	5116	62601	5000	12	180	PI(Sw)-831M	
149.410	6/3/88	Bluegrave Creek	5113	62608	5250	12	220	Sw(B)-831P	
149.410	6/10/88	Bluegrave Creek	5096	62608	4600	12	310	PISw-430G	
149.410	7/9/88	Bluegrave Creek	5166	62632	3950	24	70	PISW-822P	
149.410	7/31/88	Bluegrave Creek	5153	62633	4300	30	210	PI-420P	
149.410	11/20/88	Bluegrave Creek	5206	62696	3500	18	300	PI-522P	
149.410	2/8/89	Bluegrave Creek	5121	62614	4700	24	50	PI(Sw)-420M	
149.410	8/12/89	Bluegrave Creek	5128	62632	4900	30	200	SwB-822P	
149.410	8/27/89	Bluegrave Creek	5145	62633	4300	36	140	PISW-420P	
149.410	11/13/89	Bluegrave Creek	5132	62655	4650	36	360	Subalpine	
149.410	2/13/90	Bluegrave Creek	5168	62642	5200	50	220	Alpine	
149.410	3/5/90	Bluegrave Creek	5167	62643	5100	60	210	Alpine	
149.410	5/23/90	Bluegrave Creek	5133	62646	4500	60	360	Subalpine	
149.410	6/5/90	Bluegrave Creek	5127	62645	4500	36	280	Subalpine	
149.410	7/4/90	Bluegrave Creek	5160	62626	5000	50	180	PISW-420M	
149.410	9/26/91	Bluegrave Creek	5193	62609	3900	20	10	PISw-420M	
149.410	10/17/91	Bluegrave Creek	5200	62608	4500	12	30	SwB-mature	
149.410	10/29/91	Bluegrave Creek	5184	62606	4900	flat	ridge	Alpine	
149.410	11/14/91	Bluegrave Creek	5177	62655	3750	20	30	PI-531	
149.410	11/26/91	Bluegrave Creek	5163	62601	5400	12	100	Alpine	
149.410	12/13/91	Bluegrave Creek	5158	62635	4500	30	80	Mature PISw	
149.410	12/28/91	Halfway River	5285	62757	2650	flat	nil	Sb boa	
149.410	2/20/92	Halfway River	5306	62826	2550	6	200	Sb boa	
149.410	3/14/92	Halfway River	5292	62812	2500	flat	nil	Sb boa	

149.410	1/9/93	Halfway River	5279	62862	2550	flat	nil	Sb bog	
149.410	1/28/93	Halfway River	5303	62837	2550	flat	nil	Sb bog	
149.410	2/24/93	Halfway River	5292	62843	2550	flat	nil	Sb bog	
149.410	3/12/93	Halfway River	5294	62841	2500	flat	nil	Sb bog	
149.410	4/29/93	Crying Girl Prairie	5111	62567	3800	15	270	Pl-531	
149.410	7/26/93	3luegrave Creek	5165	62607	5000	30	360	Alpine	
149.410	9/18/93	Bluegrave Creek	5153	62598	4700	12	140	PlSw	
149.410	11/5/93	Colt Creek	5225	62542	4200	12	220	mature Pl	
149.410	12/16/93	Bluegrave Creek	5142	62612	5300	40	160	Subalpine	
149.410	3/8/94	Halfway River	5283	62867	2800	flat	nil	Sb bog	
149.410	4/28/94	Hlafway River	5267	62758	2900	flat	nil	Sb bog	
149.425	**2/12/88**	**Horseshoe Creek**	**5129**	**62777**	**5050**	**50**	**30**	**Alpine**	
149.425	3/30/88	Horseshoe Creek	5096	62770	5100	18	100	Alpine	
149.425	5/4/88	Bluegrave Creek	5306	62683	3600	6	30	SwB-841M	
149.425	6/10/88	Baldwin Creek	4563	62753	5300	30	350	Alpine	
149.425	7/31/88	Baldwin Creek	4496	62714	4650	12	180	SwPl(A)-210P	
149.425	11/20/88	Bluegrave Creek	5152	62300	3950	36	210	SwPl-420P	
149.425	1/15/89	Horseshoe Creek	5189	62747	3100	flat	nil	PlSw-420P	
149.425	2/8/89	Chowade River	5087	62796	4650	36	260	Subalpine	
149.425	3/16/89	Horseshoe Creek	5143	62726	4700	24	360	Alpine	
149.425	8/12/89	Baldwin Creek	4517	62733	5200	6	190	Subalpine	
149.425	8/27/89	Baldwin Creek	4505	62675	4000	30	230	PlSw(A)-210P	
149.425	11/23/89	Bluegrave Creek	5114	62647	4600	12	240	PlSw-310P	
149.425	3/5/90	Horseshoe Creek	5212	62729	3200	12	110	Mature Sw	
149.425	9/26/91	Baldwin Creek	4497	62733	5000	10	180	Subalpine	
149.425	10/17/91	Crying Girl	5103	62643	4050	flat	nil	Sb bog	
149.425	10/29/91	Horseshoe Creek	5090	62712	5100	40	40	Alpine	
149.425	11/4/91	Horseshoe Creek	5147	62653	4900	40	260	Subalpine	
149.425	11/26/91	Horseshoe Creek	5264	62747	2800	flat	nil	Sb bog	
149.425	12/13/91	Horseshoe Creek	5250	62711	3700	10	360	Mature Pl	
149.425	12/28/91	Horseshoe Creek	5285	62761	2650	flat	nil	Sb bog	
149.425	2/20/92	Bluegrave Creek	5277	62686	2750	6	50	SwPl mature	

149.425	9/26/91	Baldwin Creek	4497	62733	5000	10	180	Subalpine	
149.425	10/17/91	Crying Girl	5103	62643	4050	flat	nil	Sb boa	
149.425	10/29/91	Horseshoe Creek	5090	62712	5100	40	40	Alpine	
149.425	11/4/91	Horseshoe Creek	5147	62653	4900	40	260	Subalpine	
149.425	11/26/91	Horseshoe Creek	5264	62747	2800	flat	nil	Sb boa	
149.425	12/13/91	Horseshoe Creek	5250	62711	3700	10	360	Mature Pl	
149.425	12/28/91	Horseshoe Creek	5285	62761	2650	flat	nil	Sb boa	
149.425	2/20/92	Bluegrave Creek	5277	62686	2750	6	50	SwPl mature	
149.425	3/14/92	Horseshoe Creek	5158	62701	4400	36	80	Alpine	
149.425	4/15/92	Horseshoe Creek	5187	62742	3100	flat	nil	SbPl	
149.425	5/15/92	Horseshoe Creek	5213	62755	3450	24	40	Mature Pl	
149.425	8/1/92	Ospika River	4521	62705	5400	50	300	Subalpine	
149.425	9/30/92	Horseshoe Creek	5115	62737	5250	18	120	Subalpine	
149.425	10/28/92	Horseshoe Creek	5105	62744	5000	10	230	Subalpine	
149.425	2/24/93	Bluegrave Creek	5157	62692	3900	20	360	Scrub Pl	
149.425	3/12/93	Horseshoe Creek	5185	62731	3100	flat	nil	Sb boa	
149.425	7/26/93	Ospika River	4515	62735	5800	15	180	Subalpine	
149.425	8/19/93	Ospika River	4103	62724	4700	30	180	Subalpine	
149.425	9/18/93	Ospika River	4512	62688	4600	30	270	Mature SwB	
149.425	11/5/93	Bluegrave Creek	5187	62698	3300	12	110	Scrub Pl	
149.425	12/16/93	Horseshoe Creek	5189	62677	3400	12	100	Mature Pl	Mortality, signal
149.435	**2/23/88**	**Dunlevy Creek**	**5321**	**62428**	**5200**	**flat**	**ridge**	**Alpine**	
149.435	3/30/88	Hackney Hills	5233	62554	5000	flat	ridge	Alpine	
149.435	4/28/88	Hackney Hills	5183	62492	4050	12	200	SwPl-310P	
149.435	5/31/88	Schooler Creek	5008	62360	5300	6	90	Alpine	
149.435	6/14/88	Schooler Creek	5003	62347	6100	12	190	Alpine	
149.435	7/31/88	Schooler Creek	5009	62440	5000	18	40	Subalpine	
149.435	2/8/88	Schooler Creek	4998	62405	5000	24	270	Alpine	Mortality signal
149.435A	**2/25/89**	**Hackney Hills**	**5241**	**62543**	**5000**	**6**	**180**	**Alpine**	

149.435A	8/12/89	Wicked River	4631	62380	4800	12	200	Subalpine	
149.435A	8/27/89	Wicked River	4613	62381	4700	20	30	Subalpine	
149.435A	11/23/89	Aylard Ridge	5251	62413	4700	12	160	Subalpine	
149.435A	7/4/90	Nabesche River	4684	62436	4700	6	200	Subalpine	
149.435A	9/26/91	Graham River	5214	62495	4300	6	90	Mature Pl	Mortality signal
149.445	**2/23/88**	**Hackney Hills**	**5169**	**62549**	**5200**	**12**	**360**	**Alpine**	
149.445	5/3/88	Bluegrave Creek	5211	62673	3150	6	120	SwPL-630m	
149.445	5/12/88	Graham River	4967	62584	3900	18	60	SwB-931P	
149.445	6/12/88	Mt. Ludington	4875	62505	5650	24	100	Alpine	
149.445	7/3/88	Mt. Ludington	4875	62505	5650	24	100	Alpine	
149.445	7/9/88	Mt. Ludington	4875	62505	5650	24	100	Alpine	
149.445	7/31/88	Mt. Ludington	4859	62492	5300	12	40	Alpine	
149.445	11/12/88	Aylard Creek	5240	62352	3350	flat	nil	NPBr	
149.445	1/15/89	Aylard Creek	5225	62439	5050	12	360	Subalpine	
149.445	2/8/89	Aylard creek	5225	62439	5050	12	360	Subalpine	
149.445	8/12/89	Mt. Ludington	4892	62528	5400	6	210	Subalpine	
149.445	8/27/89	Mt. Ludington	4903	62513	5500	24	200	SwB-831P	
149.445	11/23/89	Mt. Ludington	4874	62541	5350	18	40	Subalpine	
149.445	2/13/90	Mt. Ludington	4876	62534	5800	6	70	Alpine	
149.445	3/5/90	Mt. Ludington	4915	62437	4800	40	90	SwPl(B)-430	
149.445	6/5/90	Mt. Ludington	4879	62515	6300	12	320	Alpine	
149.445	7/4/90	Mt. Ludington	4893	62482	5500	24	50	Alpine	
149.445	9/26/91	Bluegrave Creek	5192	62682	3300	flat	nil	Mature Pl	Mortality signal
149.455	**2/12/88**	**Horseshoe Creek**	**5122**	**62773**	**5150**	**24**	**220**	**Alpine**	
149.455	3/30/88	Chowade River	5128	62782	4250	60	360	Alpine	
149.455	5/4/88	Chowade River	5142	62819	3050	flat	nil	SwA(Pl)-530	
149.455	6/10/88	Horn Creek	4578	62840	4250	6	30	SW-320M	
149.455	7/2/88	Horn Creek	4568	62859	5900	20	140	Alpine	
149.455	7/31/88	Horn Creek	4568	62859	5900	20	140	Alpine	

149.455	2/8/89	Needham Creek	4834	62649	5600	36	300	Alpine	
149.455	8/12/89	Horn Creek	4597	62857	4300	6	20	SW-320M	
149.455	8/27/89	Horn Creek	4641	62831	4000	12	180	PIA(Sw)-420	
149.455	11/23/89	Graham River	4721	62807	5100	20	200	Subalpine	
149.455	3/5/90	Graham River	4739	62787	5300	36	220	Mature Sw	
149.455	5/23/90	Horn Creek	4586	62844	4200	6	320	SW-320M	
149.455	6/5/90	Baldwin Creek	4533	62881	5900	18	270	Alpine	
149.455	7/4/90	Horn Creek	4577	62864	5000	36	50	Subalpine	
149.455	9/26/91	Lady Laurier Lake	4578	62843	4300	10	90	SW-320M	
149.455	10/17/91	Horn Creek	4689	62805	3800	flat	nil	Mature PI	
149.455	10/29/91	Graham River	4731	62767	3900	10	210	Sb boa	
149.455	11/14/91	Graham River	4661	62817	3800	flat	nil	Sw riparian	
149.455	11/26/91	Graham River	4666	62805	3900	18	40	PI-532	
149.455	12/28/91	Graham River	4887	62703	3500	flat	nil	Sw Mature	
149.455	2/20/92	Big Valley	5003	62737	3650	12	20	SwPI mature	
149.455	4/15/92	Chowade River	5143	62803	4000	flat	nil	Sw mature	
149.455	5/15/92	Horn Creek	4647	62826	3900	12	110	SwB mature	
149.455	6/7/92	Ospika River	4510	62908	6500	48	200	Alpine	
149.455	8/1/92	Graham River	4724	62797	4600	12	190	PISw mature	
149.455	11/24/92	Horn Creek	4603	62840	4700	flat	nil	SwB mature	
149.455	1/9/93	Horn Creek	4593	62884	5100	15	220	Scrub PI	
149.455	2/24/93	Graham River	4828	62758	4900	10	100	SwPI mature	
149.455	3/12/93	Graham river	4831	62760	4700	10	160	SwB mature	
149.455	4/29/93	Graham River	4892	62718	3600	flat	nil	PI-531	
149.455	6/6/93	Horn Creek	4601	62830	4900	20	80	Subalpine	
149.455	7/26/93	Lady Laurier Lake	4550	62819	5100	10	360	Subalpine	
149.455	8/19/93	Lady Laurier Lake	4596	62890	4400	12	20	SwB imm.	
149.455	9/18/93	Lady Laurier Lake	4595	62799	5100	12	360	Subalpine	
149.455	1/30/94	Graham river	4855	62751	4700	flat	nil	SwB mature	
149.455	3/8/94	Graham River	4983	62705	5600	30	270	Alpine	
149.455	4/28/94	Chowade River	5017	62748	3450	flat	nil	Sb boa	

149.465	**2/5/88**	**Horseshoe Creek**	**5094**	**62774**	**5150**	**30**	**10**	**Alpine**	
149.465	3/30/88	Horseshoe Creek	5128	62778	5000	30	20	Alpine	
149.465	4/28/88	Horseshoe Creek	5135	62769	5100	6	120	Alpine	
149.465	5/21/88	Horseshoe Creek		-	-	-	-	-	
149.465	6/3/88	Chowade River	4999	62884	5100	24	200	Alpine	
149.465	6/10/88	Chowade river	4999	62884	5100	24	200	Alpine	
149.465	6/22/88	Cypress Creek	4970	62956	5650	24	300	Alpine	
149.465	7/5/88	Big Valley	5045	62721	5000	18	360	PlSw-310 p	
149.465	7/31/88	Horseshoe Creek	5114	62734	5100	30	210	PlSw-310 p	
149.465	11/20/88	Horseshoe Creek	5081	62734	5000	36	130	Subalpine	
149.465	2/8/89	Horseshoe Creek	5121	62776	5150	6	320	Alpine	
149.465	3/16/89	Horseshoe Creek	5094	62766	5000	6	180	Alpine	
149.465	8/12/89	Horseshoe Creek	5088	62778	5200	36	240	Subalpine	
149.465	8/27/89	Horseshoe Creek	5107	62746	5000	18	60	Subalpine	
149.465	11/23/89	Chowade River	5103	62869	4600	12	50	SwPl-821 p	
149.465	2/13/90	Horseshoe Creek	5119	62743	5000	30	360	Subalpine	
149.465	3/5/90	Horseshoe Creek	5118	62778	5200	18	330	Subalpine	
149.465	5/23/90	Horseshoe Creek	5143	62743	3300	12	110	Pl-531M	
149.465	6/5/90	Horseshoe Creek	5088	62744	5000	30	120	Subalpine	
149.465	7/4/90	Horseshoe Creek	5115	62783	4500	50	40	Subalpine	
149.465	9/26/91	Chowade River	5100	62811	3500	40	40	Sw(Pl)-731 m	
149.465	10/17/91	Chowade river	5088	62885	4750	flat	ridge	Subalpine	
149.465	10/29/91	Cypress Burn	5125	62892	3200	flat	nil	Sb boa	
149.465	11/14/91	Cypress Creek	5083	62892	4600	20	360	Subalpine	
149.465	11/26/91	Cypress Burn	5097	62877	4800	6	40	Subalpine	
149.465	12/13/91	Cypress Burn	5118	62881	3350	10	90	Sb boa	
149.465	12/28/91	Cypress Burn	5120	62922	3600	6	90	Scrub Pl	
149.465	2/20/92	Chowade River	5108	62853	4600	18	230	SwB mature	
149.465	3/14/92	Chowade River	5127	62792	4600	18	40	Alpine	
149.465	4/15/92	Horseshoe Creek	5109	62742	5050	12	290	Subalpine	

149.465	5/15/92	Horseshoe Creek	5112	62743	5200	36	350	Subalpine	
149.465	6/7/92	Horseshoe Creek	5100	62749	5100	flat	ridge	Alpine	
149.465	8/1/92	Horseshoe Creek	5107	62749	4600	30	50	Subalpine	
149.465	9/30/92	Chowade River	4803	62800	5700	24	60	Subalpine	
149.465	10/28/92	Horseshoe Creek	5151	62825	2950	flat	nil	Sb boa	
149.465	11/24/92	Horseshoe Creek	5141	62748	3500	36	200	Pl-521	
149.465	1/9/93	Horseshoe Creek	5128	62757	4200	10	180	BSw mature	
149.465	2/24/93	Horseshoe Creek	5125	62772	4900	30	170	Subalpine	
149.465	3/12/93	Horseshoe Creek	5131	62773	5100	flat	nil	Alpine	
149.465	4/26/93	Horseshoe Creek	5121	62775	5100	10	270	Subalpine	
149.465	6/6/93	Horseshoe Creek	5067	62754	4300	60	290	SwB mature	
149.465	7/26/93	Horseshoe Creek	5096	62755	5000	50	90	Subalpine	
149.465	8/19/93	Horseshoe Creek	5128	62759	4200	25	200	Pl mature	
149.465	9/18/93	Horseshoe Creek	5107	62770	4700	40	180	SwPl mature	
149.465	12/16/93	Horseshoe Creek	5099	62754	5000	40	340	Subalpine	
149.465	1/30/94	Horseshoe Creek	5133	62771	5100	12	190	Subalpine	
149.465	3/8/94	Horseshoe Creek	5138	62751	3500	40	200	Pl mature	
149.465	4/28/94	Horseshoe Creek	5123	62782	4750	12	90	Subalpine	
149.465	5/26/94	Horseshoe Creek	5091	62711	5200	30	60	Subalpine	
149.475	**3/23/88**	**Aylard Ridge**	**5284**	**62370**	**4700**	**12**	**90**	**Alpine**	
149.475	3/30/88	Aylard Ridge	5239	62401	5150	24	270	Alpine	
149.475	11/20/88	Aylard Ridge	5280	62339	5700	6	140	Alpine	
149.475	2/8/89	Aylard Ridge	5322	62442	4950	6	360	Alpine	
149.475	8/12/89	Nabesche River	4748	62408	5500	30	190	Subalpine	
149.475	8/27/89	Nabesche River	4761	62452	3900	12	360	SwB-831P	
149.475	3/5/90	Aylard Ridge	5312	62429	5000	6	190	Alpine	
149.475	6/5/90	Wicked River	4584	62416	5700	30	90	Alpine	
149.475	7/4/90	Wicked River	4627	62403	6000	6	180	Alpine	
148.310	**2/25/89**	**Butler Ridge**	**5443**	**62295**	**5200**	**12**	**80**	**Alpine**	

148.310	3/16/89	Butler Ridge	5427	62329	5250	flat	nil	Alpine	
148.310	8/12/89	Aylard Ridge	5282	62368	5500	36	200	Subalpine	
148.310	8/27/89	Aylard Ridge	5281	62373	5500	36	90	Subalpine	
148.310	11/23/89	Butler Ridge	5466	62237	4500	18	70	Subalpine	
148.310	2/13/90	Farrell Creek	5538	62358	2600	flat	nil	Imm. Sw	
148.310	3/5/90	Farrell Creek	5523	62365	2600	flat	nil	Imm. Sw	